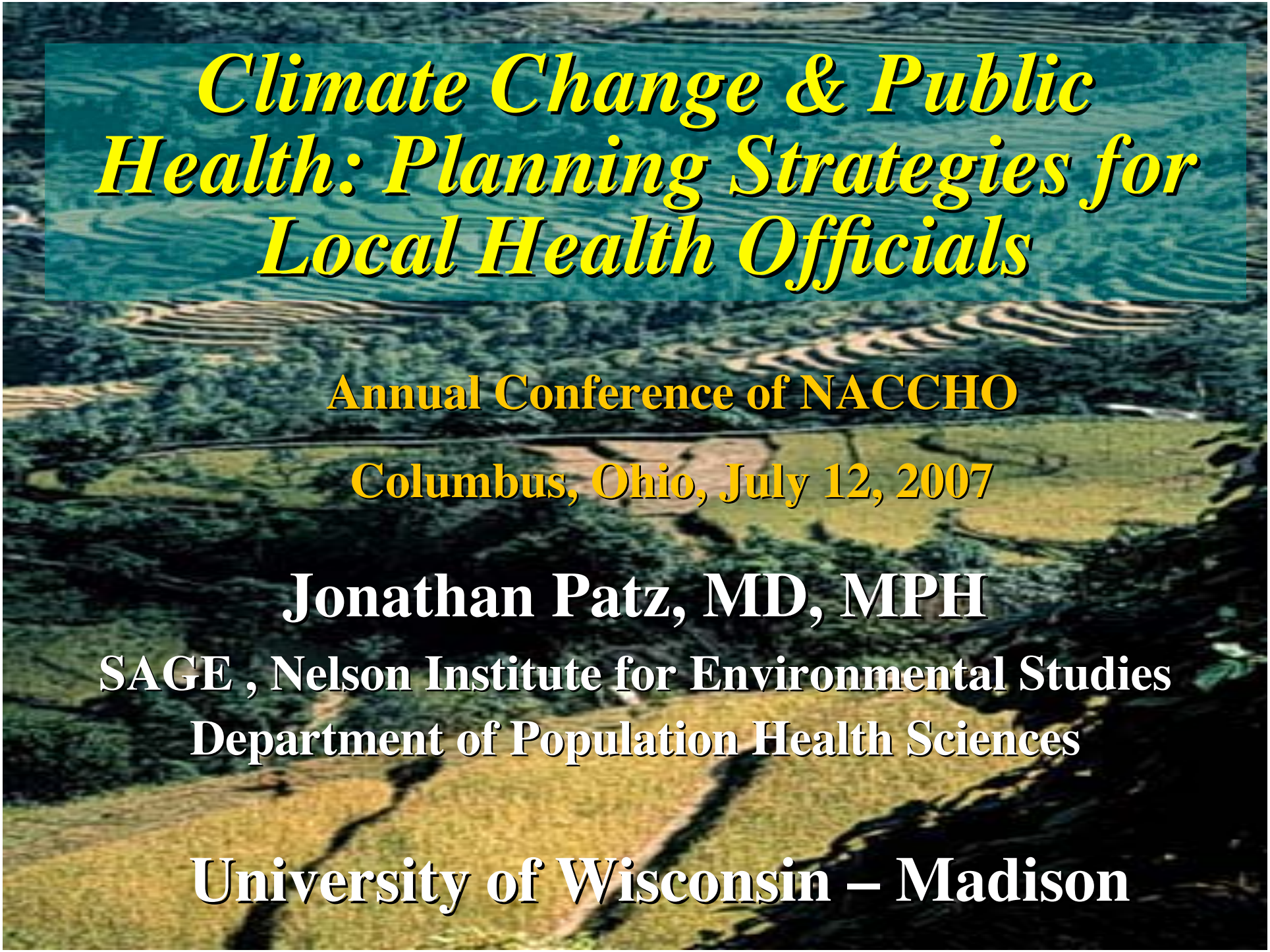

Climate Change & Public Health: Planning Strategies for Local Health Officials

Annual Conference of NACCHO

Columbus, Ohio, July 12, 2007

Jonathan Patz, MD, MPH

SAGE , Nelson Institute for Environmental Studies

Department of Population Health Sciences

University of Wisconsin – Madison

Public Health Impacts of Climate Change

Presidential Management Fellows

Forum on Global Climate Change

Washington, DC July 27, 2007

Jonathan Patz, MD, MPH

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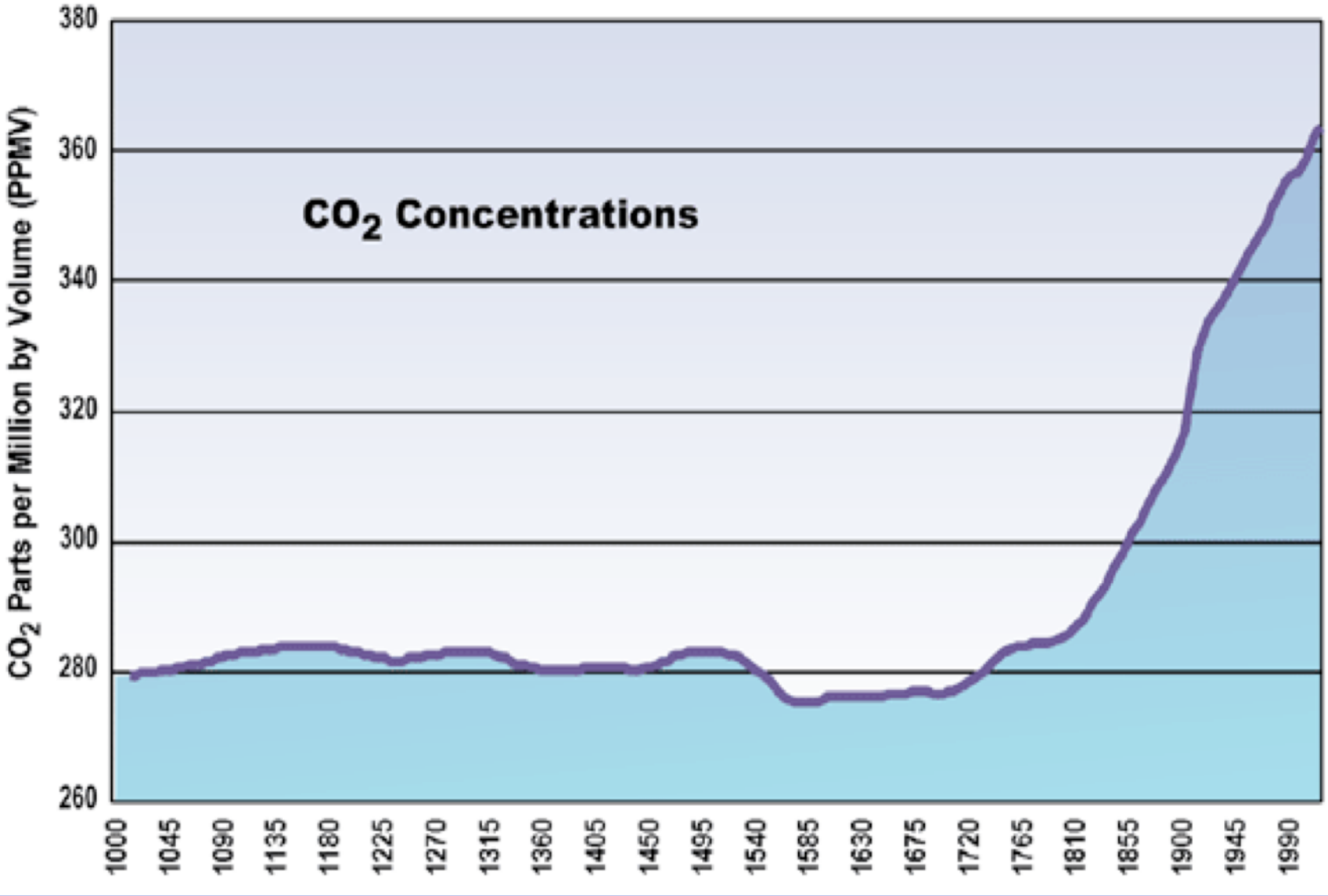
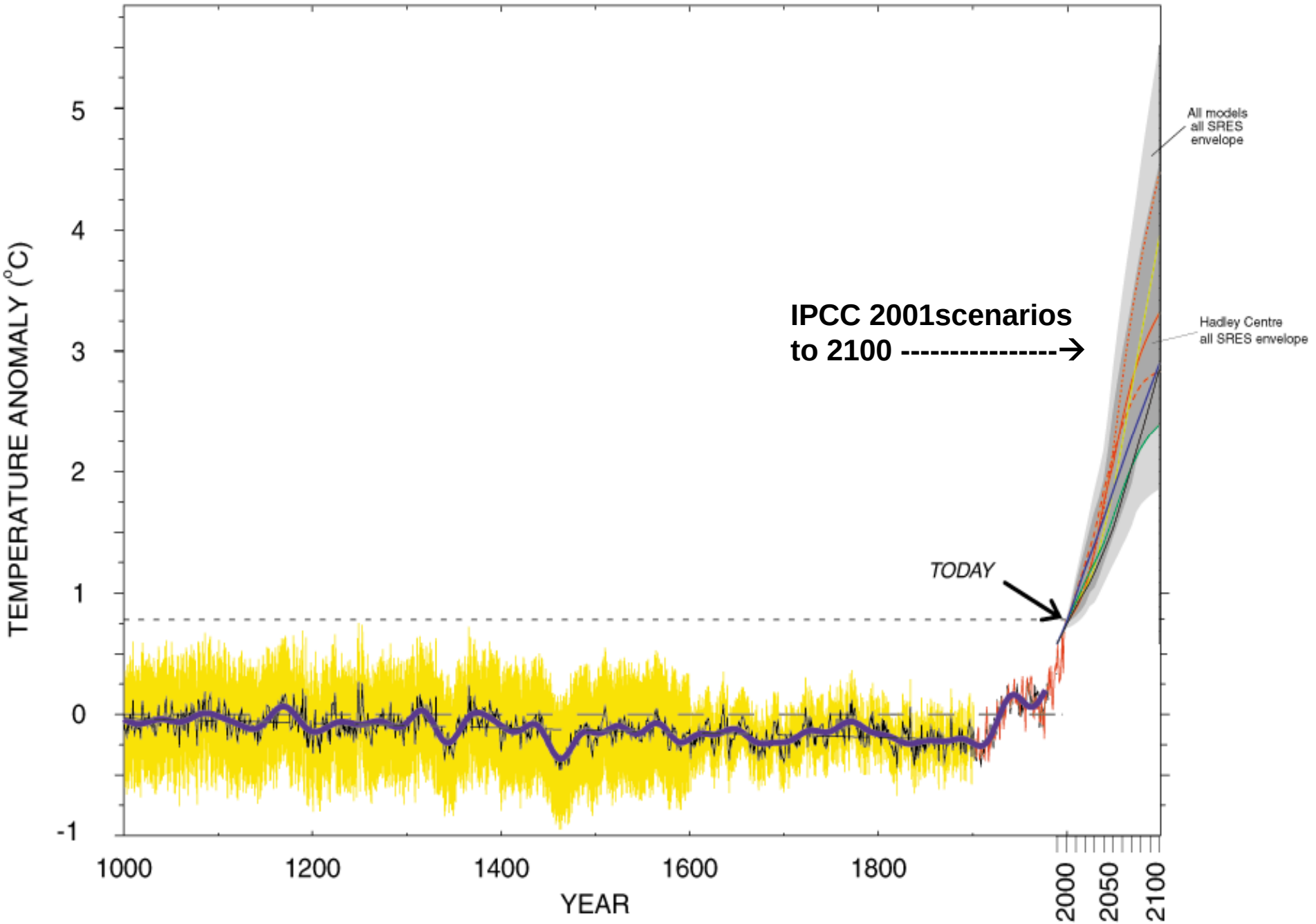

CO_2 Concentrations
CO_2 Parts per Million by Volume (PPMV)
380
360
340
320
300
280
260
1000
1045
1090
1135
1180
1225
1270
1315
1360
1405
1450
1495
1540
1585
1630
1675
1720
1765
1810
1855
1900
1945
1990

Temperature, past and future



But the polar bear might not be the only threatened species

"How it threatens your health"

December 4, 2006CDC: **Climate change a health threat**

By Christine Dell'Amore UPI

Consumer Health Correspondent

*The "rising scientific certainty" of climate change should mobilize environmental health professionals to take aggressive action, a Centers for Disease Control and Prevention director said at a meeting here Monday.**"Climate change is perhaps the largest looming public health challenge we face, certainly in the environmental health field," Dr. Howard Frumkin, director of the CDC's National Center for Environmental Health, told United Press International in an interview**. In the past year, climate change has reached a tipping point, in which many of the climate change predictions have become alarming, said Frumkin, who spoke at the opening session of the 2006 National Environmental Public Health Conference in Atlanta.*

HEALTH EFFECTS OF CLIMATE CHANGE

CLIMATE CHANGE

Temperature Rise [1]
Sea level Rise [2]
Hydrologic Extremes

[1] **3°C** by yr. 2100
[2] **40 cm** " "
IPCC estimates

Patz, 1998

Urban Heat Island Effect	Heat Stress Cardiorespiratory failure
Air Pollution & Aeroallergens	Respiratory diseases, e.g., COPD & Asthma
Vector-borne Diseases	Malaria Dengue Encephalitis Hantavirus Rift Valley Fever
Water-borne Diseases	Cholera Cyclospora Cryptosporidiosis Campylobacter Leptospirosis
Water resources & food supply	Malnutrition Diarrhea Toxic Red Tides
Environmental Refugees	Forced Migration Overcrowding Infectious diseases Human Conflicts

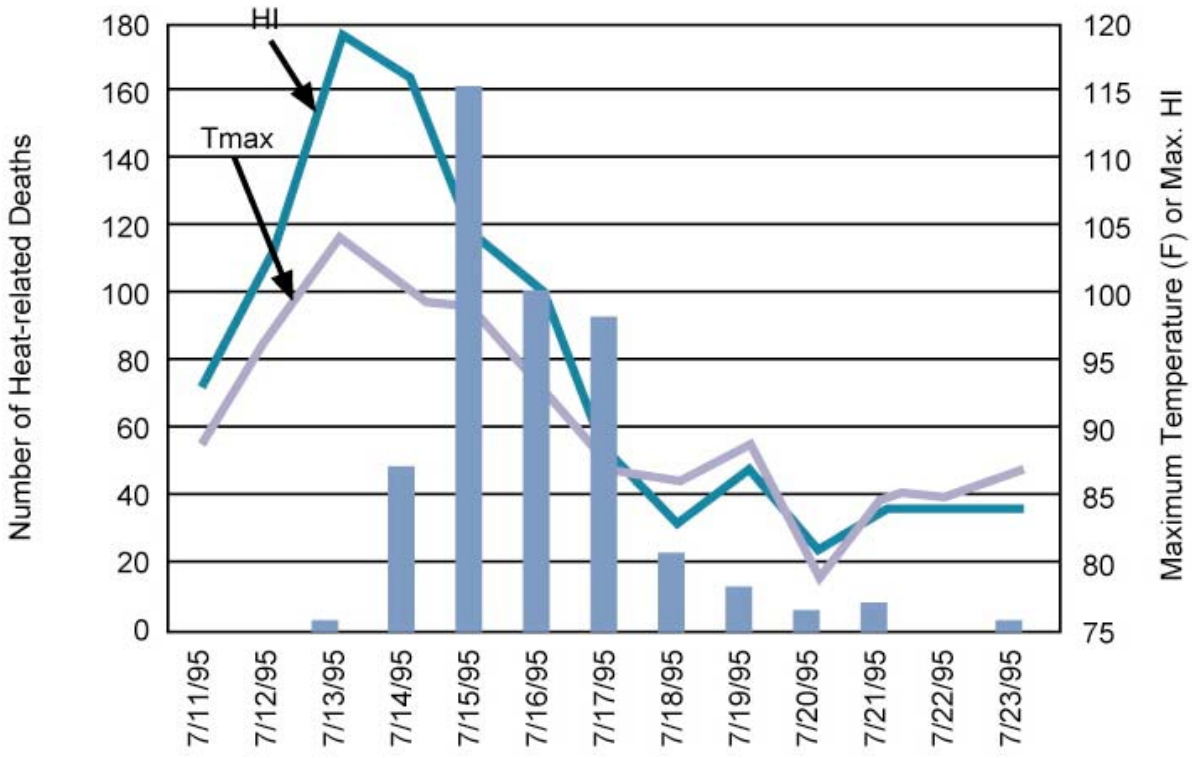
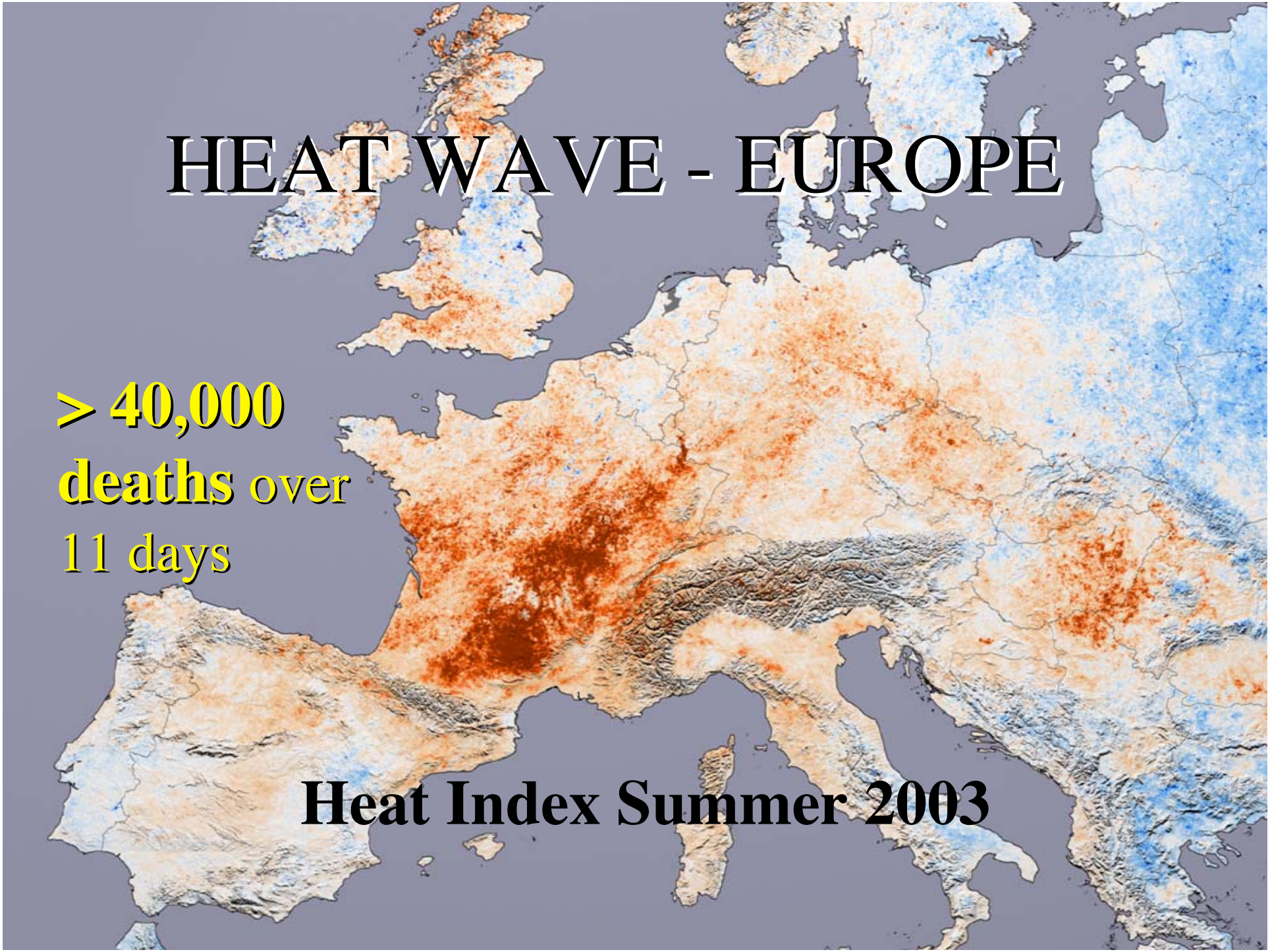


Figure 3: This graph tracks the maximum temperature (Tmax), heat index (HI), and heat-related deaths in Chicago each day from July 11 to 23, 1995. The gray line shows maximum daily temperature, the blue line shows the heat index, and the bars indicate the number of deaths each day. Source: NOAA/NCDC.

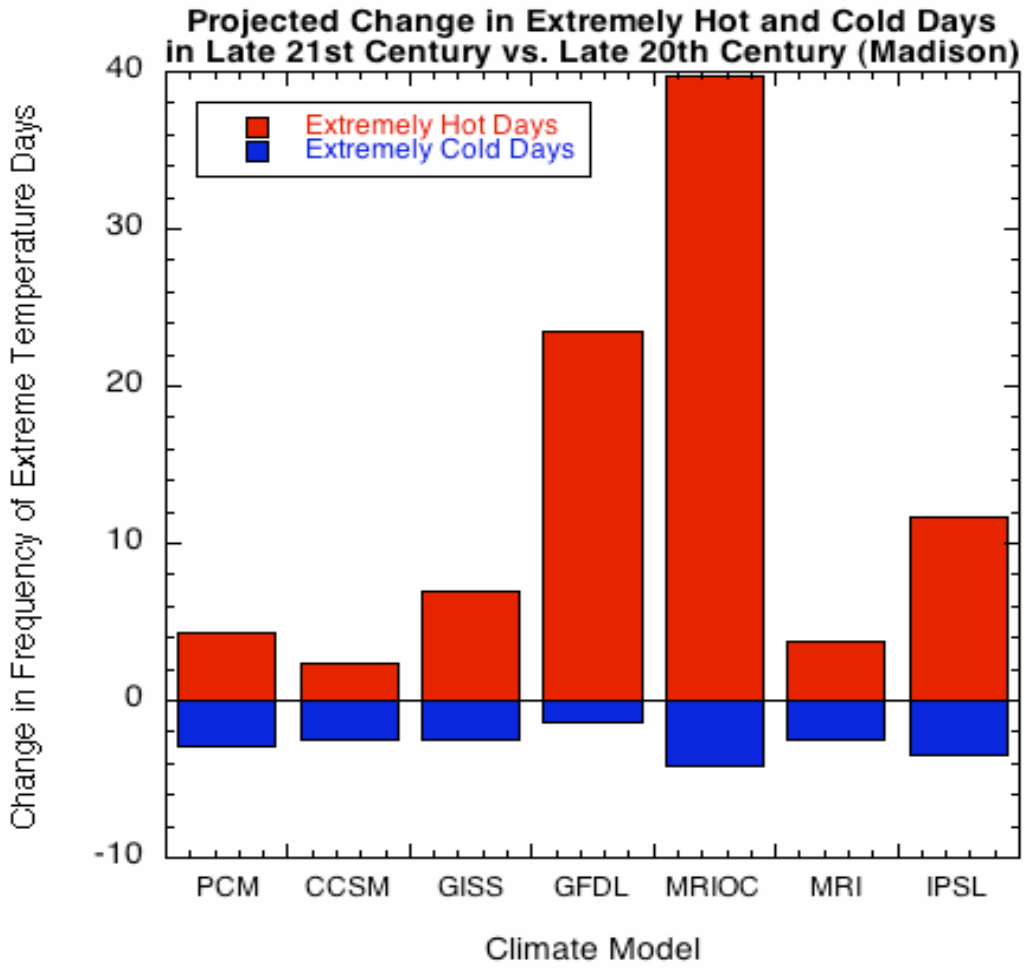

HEAT WAVE - EUROPE
> 40,000
deaths over
11 days
Heat Index Summer 2003

Temperature effects to consider for adaptive strategies

- **High electricity use, some power outages (melting cable)**
- Impossibility of purchasing electricity from outside France
- Rise in river temperatures: over 32°C in Chinon
- **Difficulty cooling power plants, one nuclear power plant in Mulhouse (Alsace) shut down**

Courtesy: Rick Keller

Projected change in number of extremely hot and cold days, southern Wisconsin- 7 GCMs by the late 21st century



Courtesy: S. Vavrus

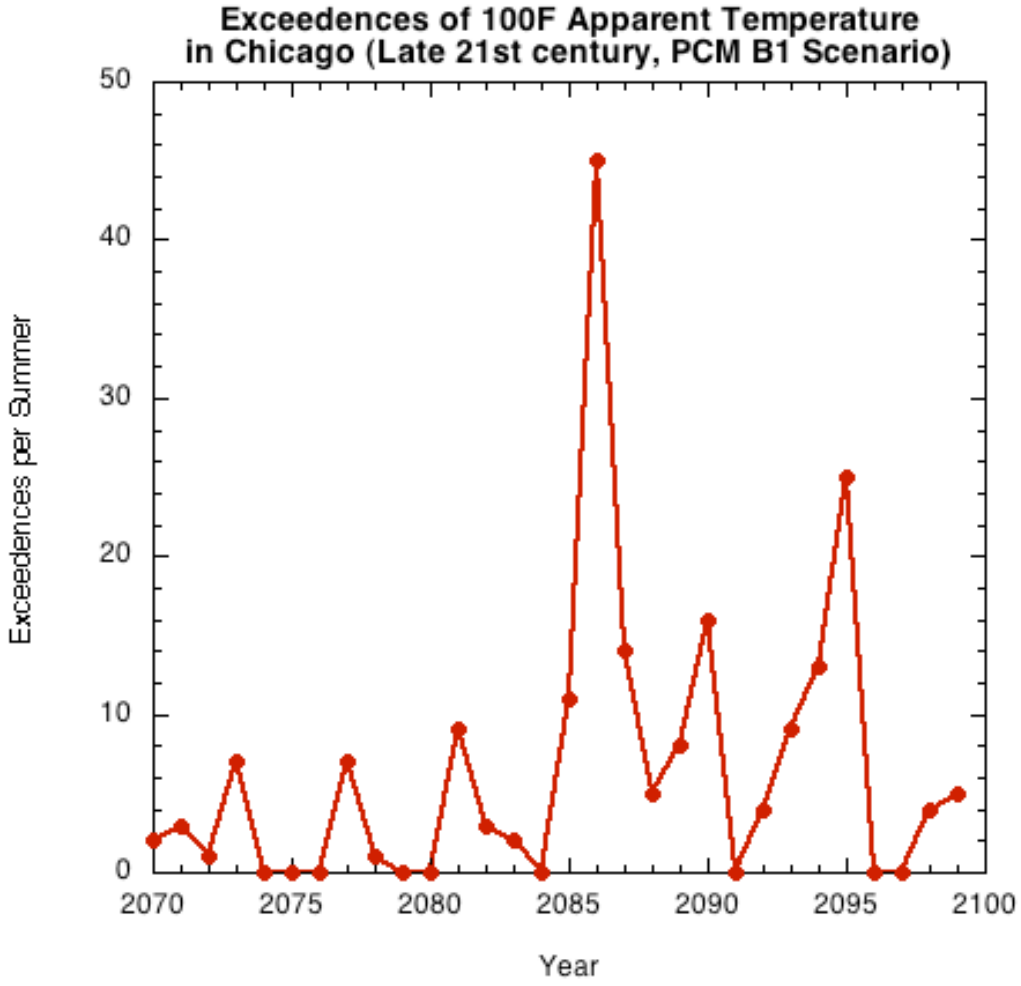
Universiy of Wisconsin-Madison

Unpublished data

EPA STAR Grant project

J Patz, PI

Projected exceedences of maximum daily 100°F apparent temperature in Chicago by the late 21st century, based on the PCM climate model's B1 emissions scenario



Courtesy: S. Vavrus

Universiy of Wisconsin-Madison

Unpublished data

EPA STAR Grant project

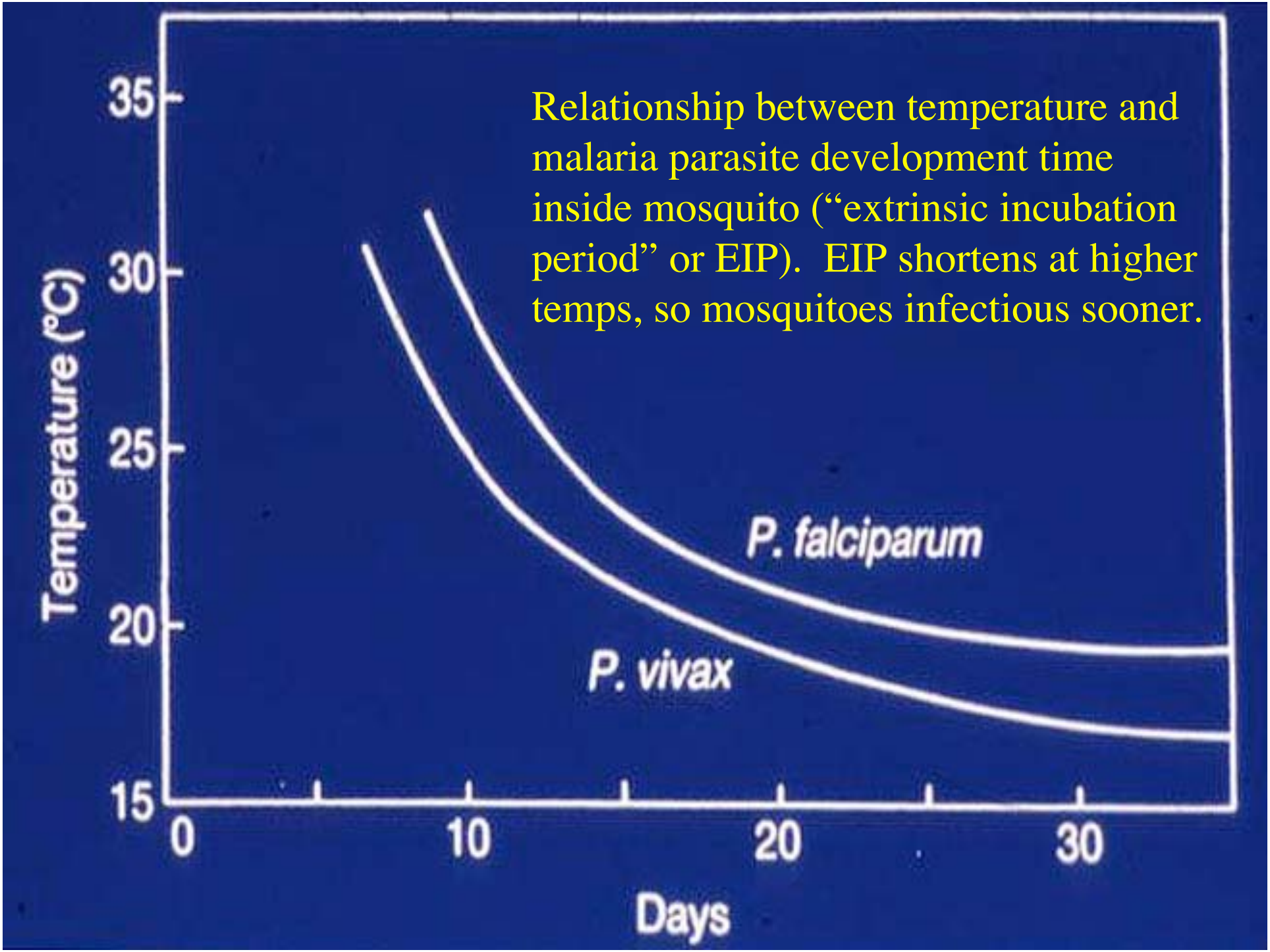
J Patz, PI

Note: this much variability will make planning extremely difficult

- **"The severity and duration of summertime regional air pollution episodes are projected to increase in the Northeast and Midwest US by 2045-2052 due to climate-change-induced decreases in the frequency of surface cyclones."** (IPCC, 2007)

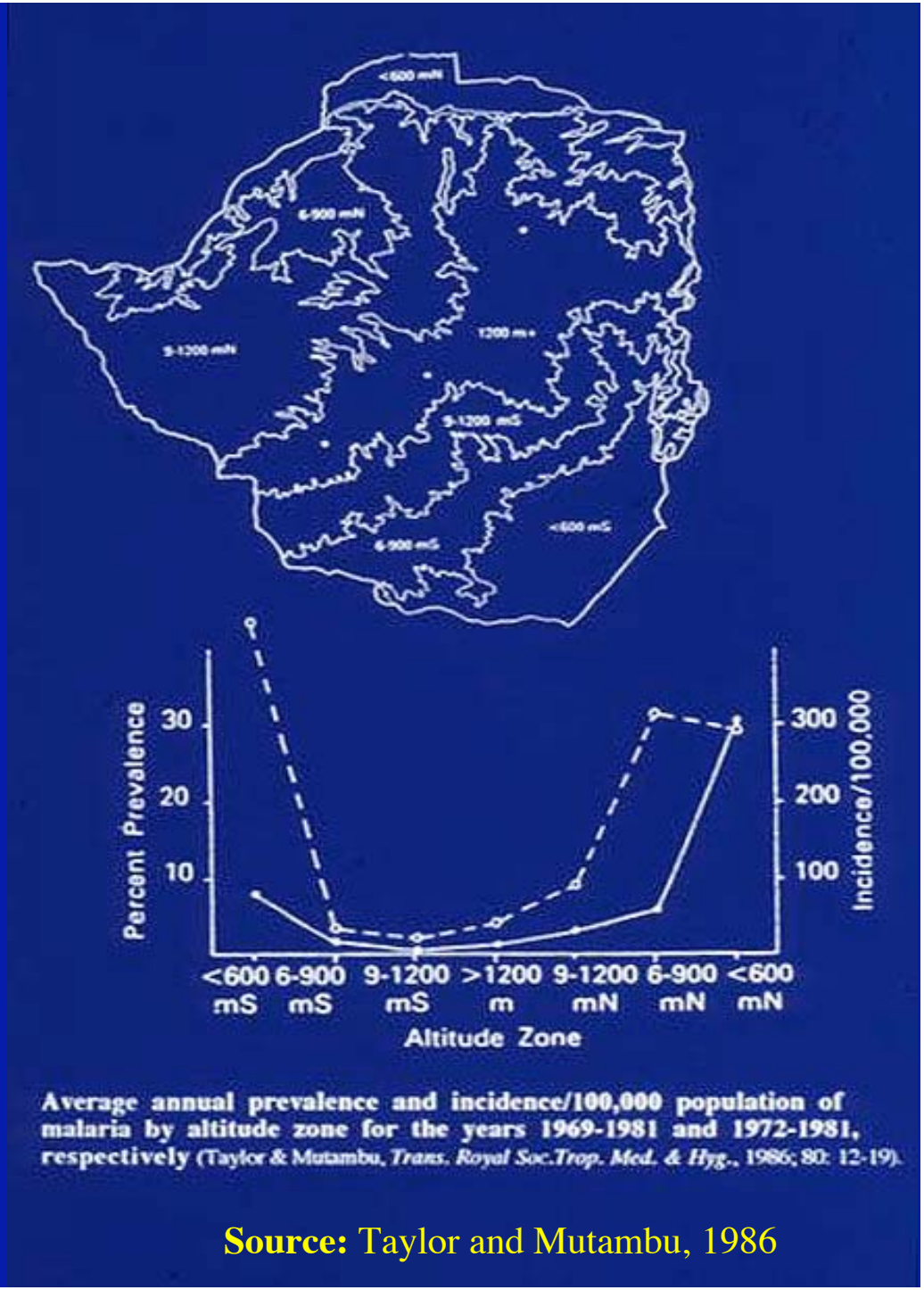
- **By 2050, warming alone may increase by 68% the number of Red Ozone Alert days across the Eastern US.** (IPCC, 2007 -Bell et al, 2006)


HEALTH PROFESSIONALS AND SCIENTISTS WARN OF SPREADING INFECTIOUS DISEASES.
Global Warming's greatest threat may also be the smallest.


Relationship between temperature and malaria parasite development time inside mosquito ("extrinsic incubation period" or EIP). EIP shortens at higher temps, so mosquitoes infectious sooner.
Temperature (°C)
35
30
25
20
15
0
10
20
30
Days
P. falciparum
P. vivax

Relationship between malaria and altitude, Zimbabwe.

Altitude a good surrogate for temperature: the average temperature decrease with height = **6°C per 1000 meters**

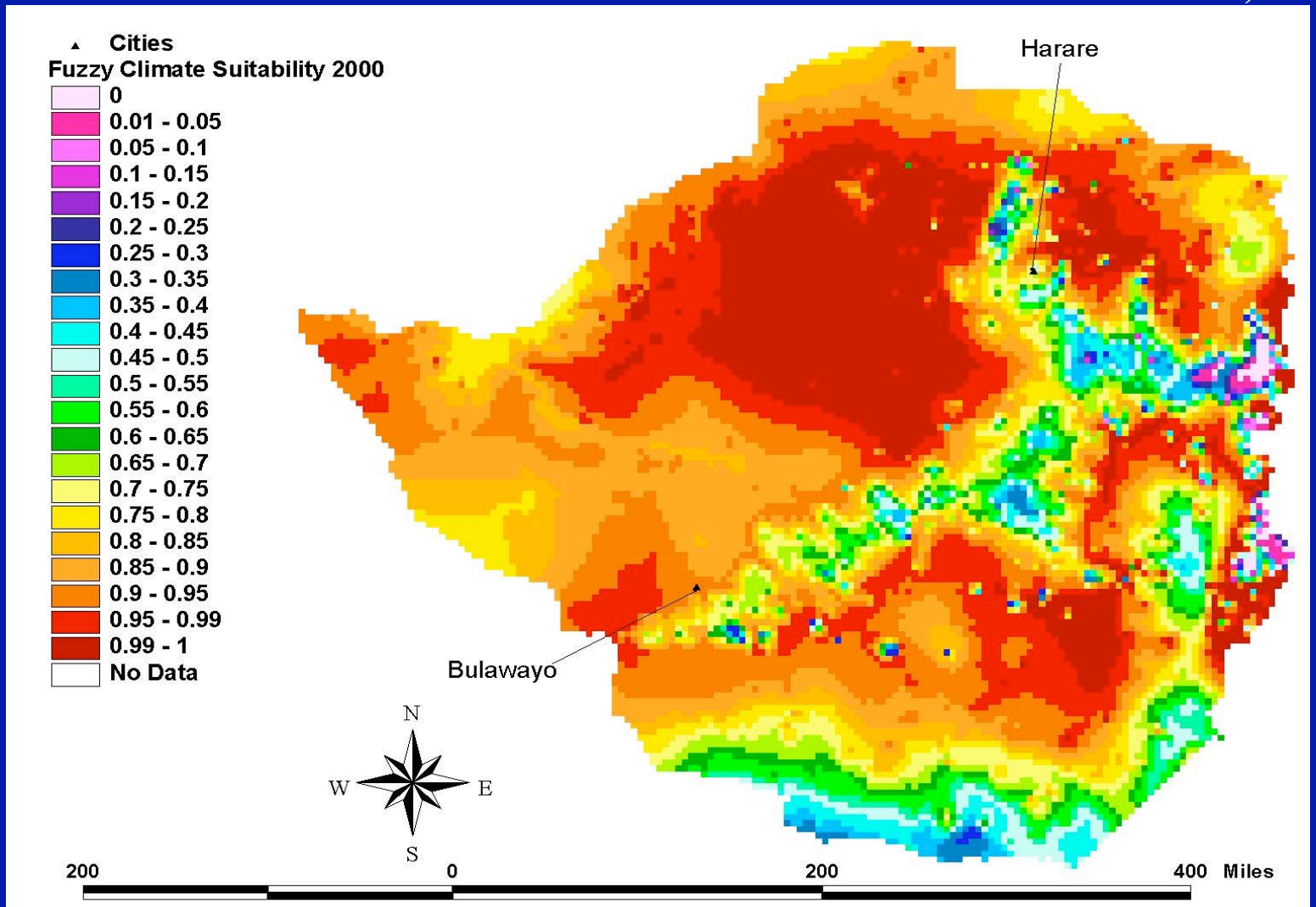


Average annual prevalence and incidence/100,000 population of malaria by altitude zone for the years 1969-1981 and 1972-1981, respectively (Taylor & Mutambu, *Trans. Royal Soc.Trop. Med. & Hyg.*, 1986; 80: 12-19).

Source: Taylor and Mutambu, 1986

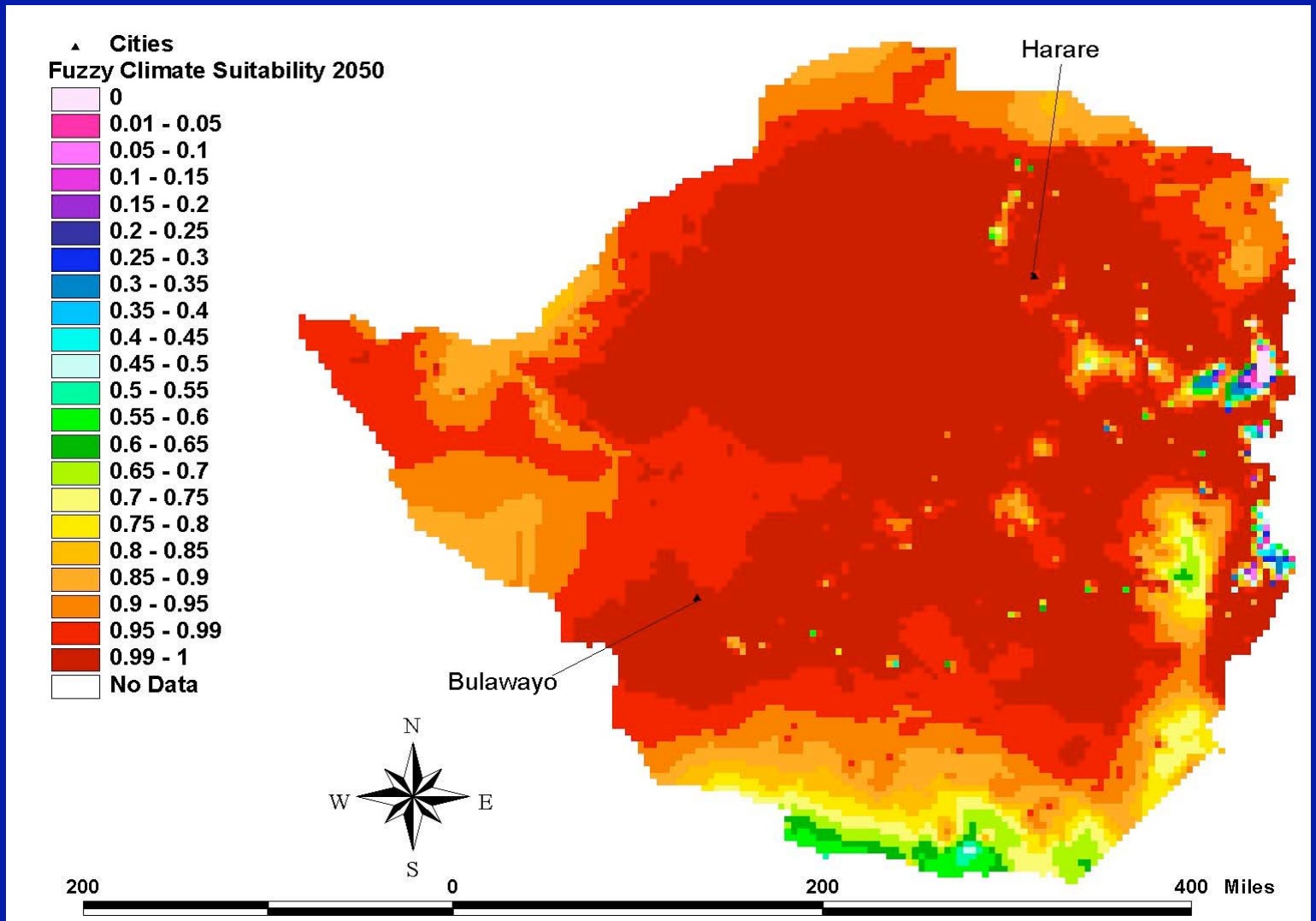
Baseline 2000 2025 2050 2075 2100

Source: Ebi et al, 2005



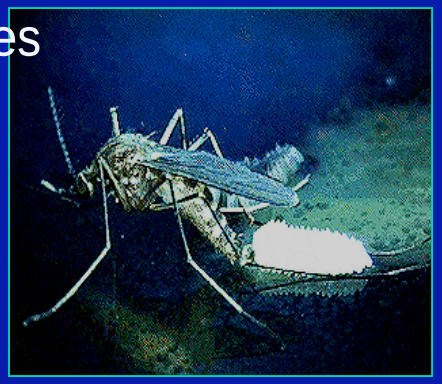
Baseline 2000 2025 ***2050*** 2075 2100

Source: Ebi et al, 2005



West Nile Virus Transmission Cycle in Old World

Mosquito vectors
Culex species



VIRUS

Dead - end Hosts

VIRUS

VIRUS

Avian reservoirs

Source: R.J. Novak
USGS, National Wildlife Health Center

Dissemination of WNV by migratory birds?

USGS, National Wildlife Health Center

Temperature Deviations 2002 vs. 2003: O' Hare Airport

DPV
MAD

April 2002 →	+2.1 F	+0.5 F	← April 2003
May	*-3.5*	*-2.5*	May
June	+2.7	*-2.7*	June
July	+3.8	*-1.0*	July
August	+1.4	+1.9	August
Sept	+3.5	*-0.4*	Sept
Deviations	+ 10	- 4.2	

Summer 2002 was near optimum for *Culex*

Note Temperature differences

2002 vs. 2003

Source: CDC

New Findings: West Nile Virus

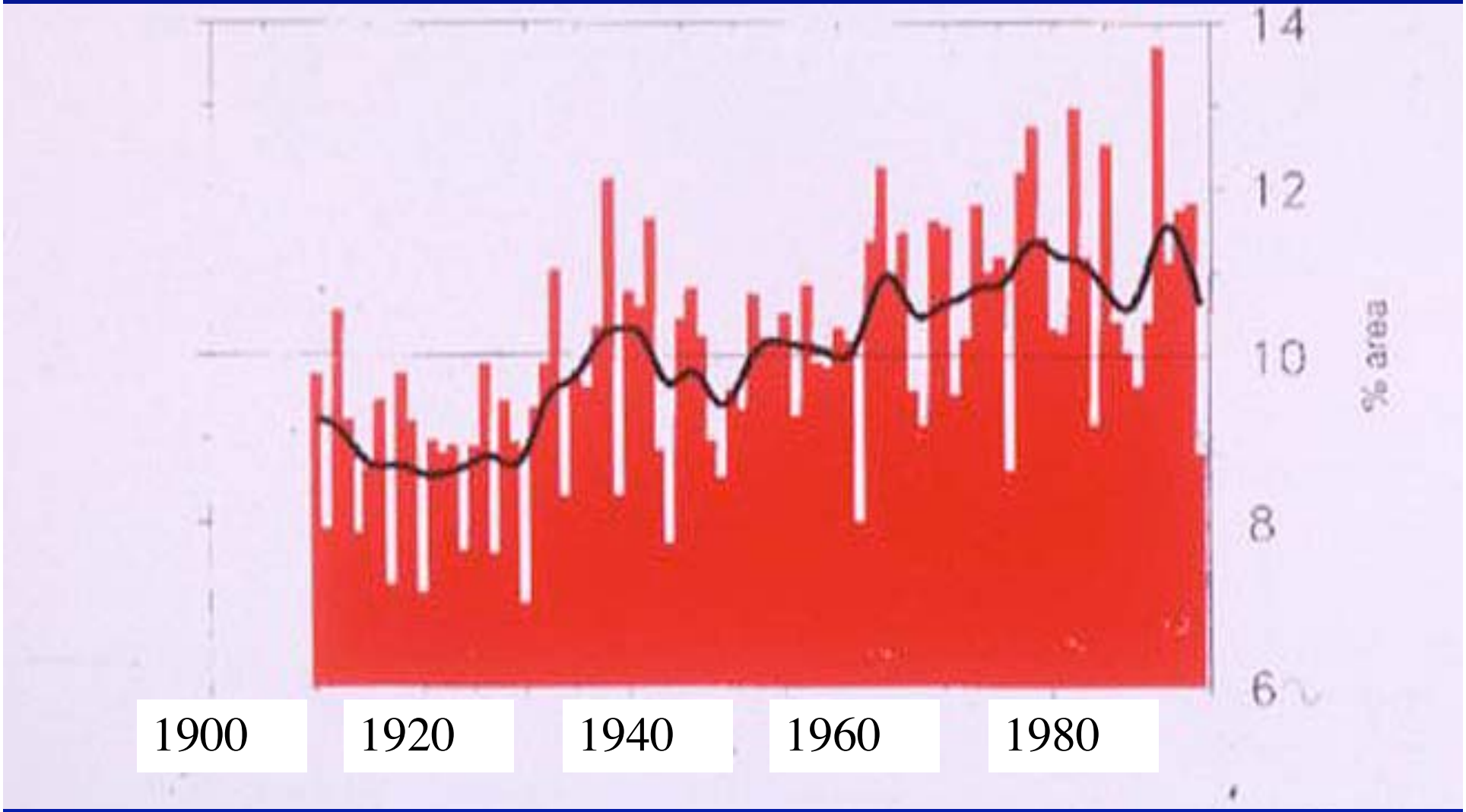
- **"The strain of West Nile virus (WNV) that emerged for the first time in North America during the record hot July, 1999, requires warmer temperatures than other strains. The greatest WNV transmissions during the epidemic summers of 2002-2004 in the U.S. were linked to above-average temperatures."**

(Reisen et al. in press)

Climate change:

It's not just about warming.

Proportion of the USA affected by much above normal annual precipitation from extreme events (>2 inches/day)



Source: Karl et al. 1996

Extreme Precipitation and Waterborne Disease Outbreaks in the United States, 1948 -1994

Project Sponsor:

US EPA, Office of Research & Development

PI: J. Patz

Results

- **67% of waterborne disease outbreaks were preceded by precipitation above the 80th percentile** (across a 50 yr. climate record), $p < 0.001$
- **51% of outbreaks were preceded by precipitation above the 90th percentile,** $p < 0.002$
- Surface water-related outbreaks had strongest correlation with extreme precipitation in the month of outbreak; groundwater-related outbreaks lagged 2 months following extreme precipitation.

Curriero, Patz, et al, 2001.

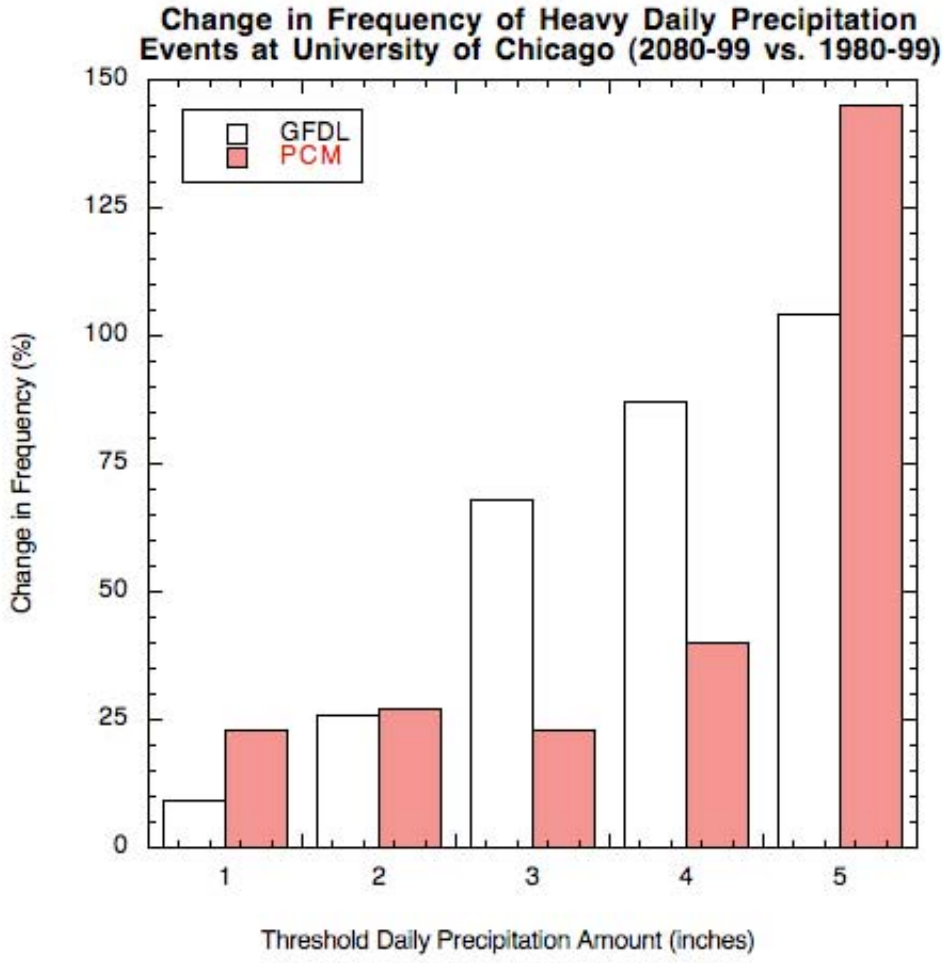
USA: Combined sewer overflows (CSOs)

Courtesy: Kellogg Schwab

1.2 trillion gal of sewage & stormwater a year discharged during combined sewer overflows – would keep Niagara Falls roaring for 18 days

Center for Water & Health, JHU Bloomberg School of Public Health

Projected change in the frequency of heavy precipitation in Chicago by the late 21st century, based on downscaled climate model output from two GCMs used in the Chicago Climate Impact Assessment.



Courtesy: S. Vavrus

Universiy of Wisconsin-Madison

Unpublished data

EPA STAR Grant project

J Patz, PI

Ethics

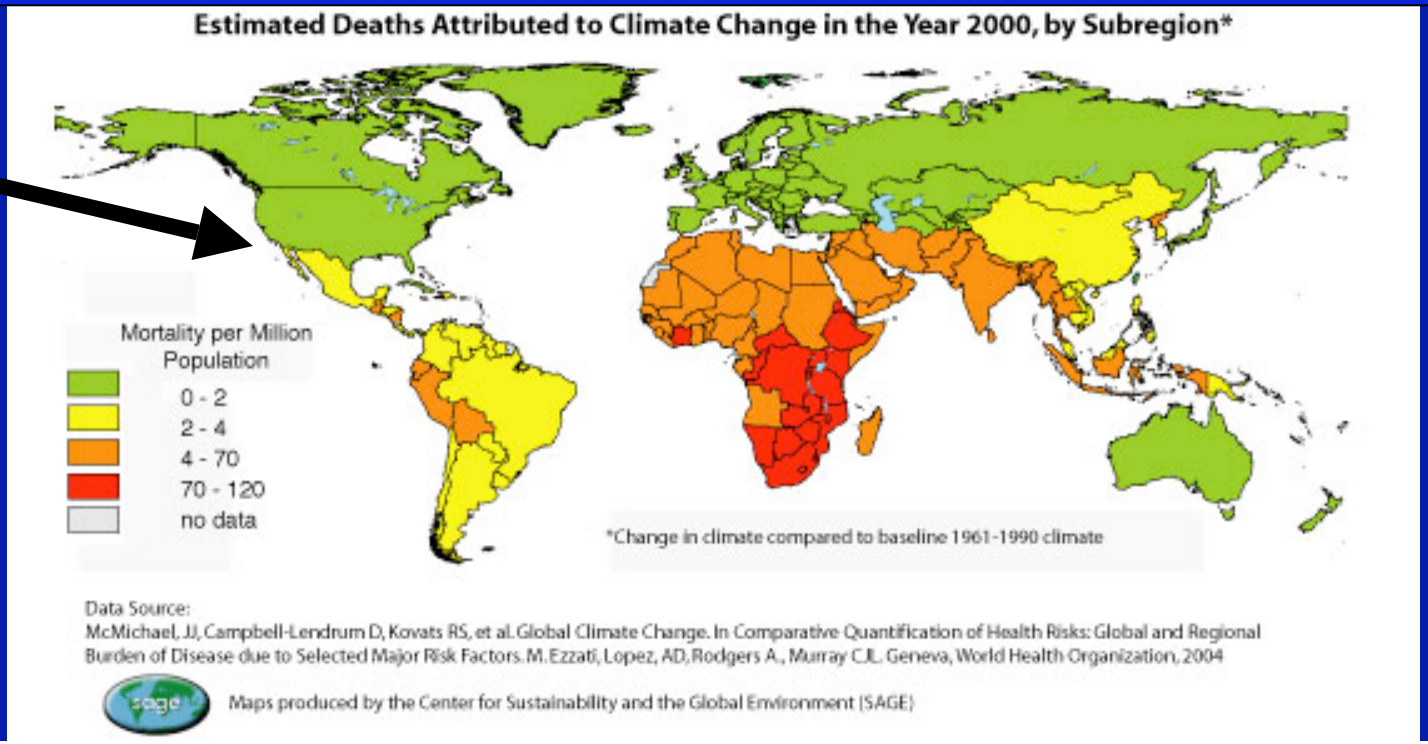
Climate Change and Health


New Orleans
after Hurricane Katrina

Climate change is already contributing to morbidity and mortality

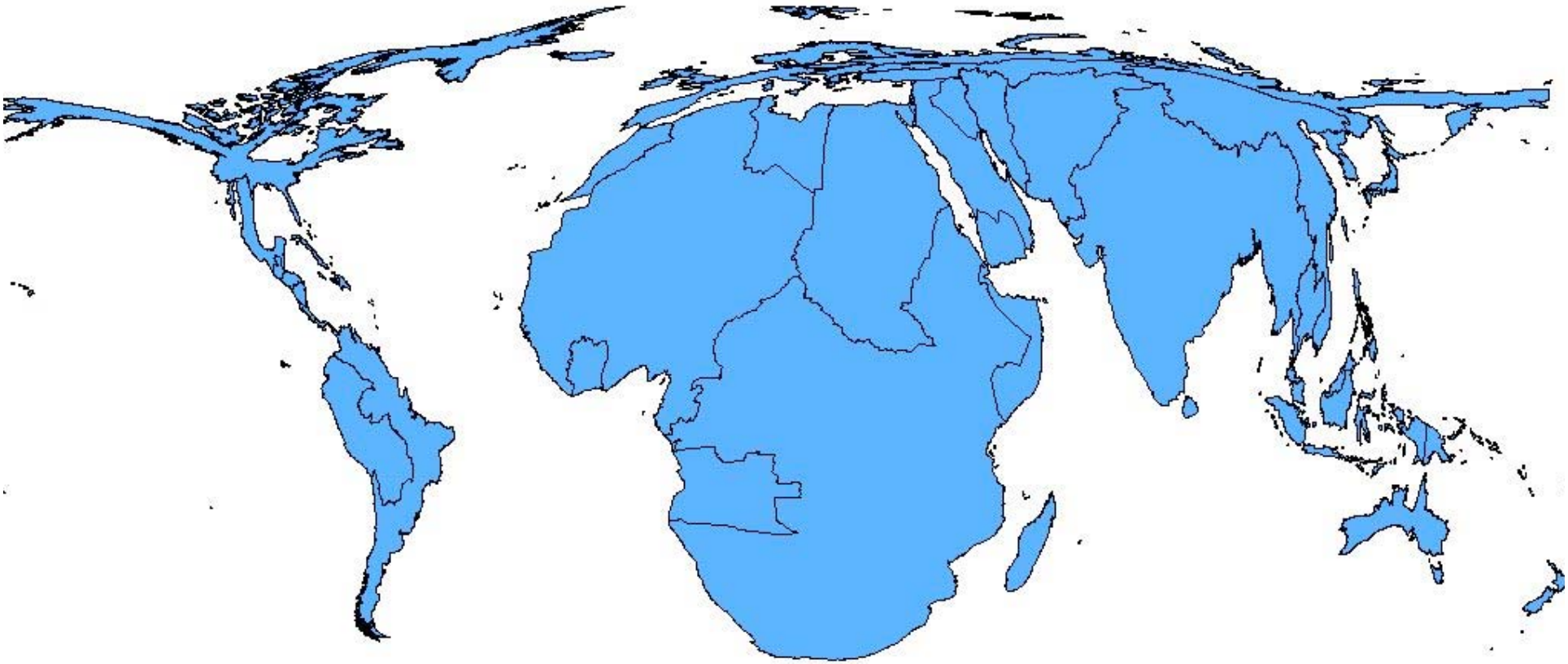
Warming during 1970-2000 is estimated to have caused at least 160,000 deaths and 5 million DALYs annually (from just 4 outcomes: malaria, diarrhea, malnutrion, and flooding). WHO, 2004.

Climate-related burden of disease



Sources:
McMichael et al; 2003
Campbell-Lendrum et al; 2004
Patz et al. 2005

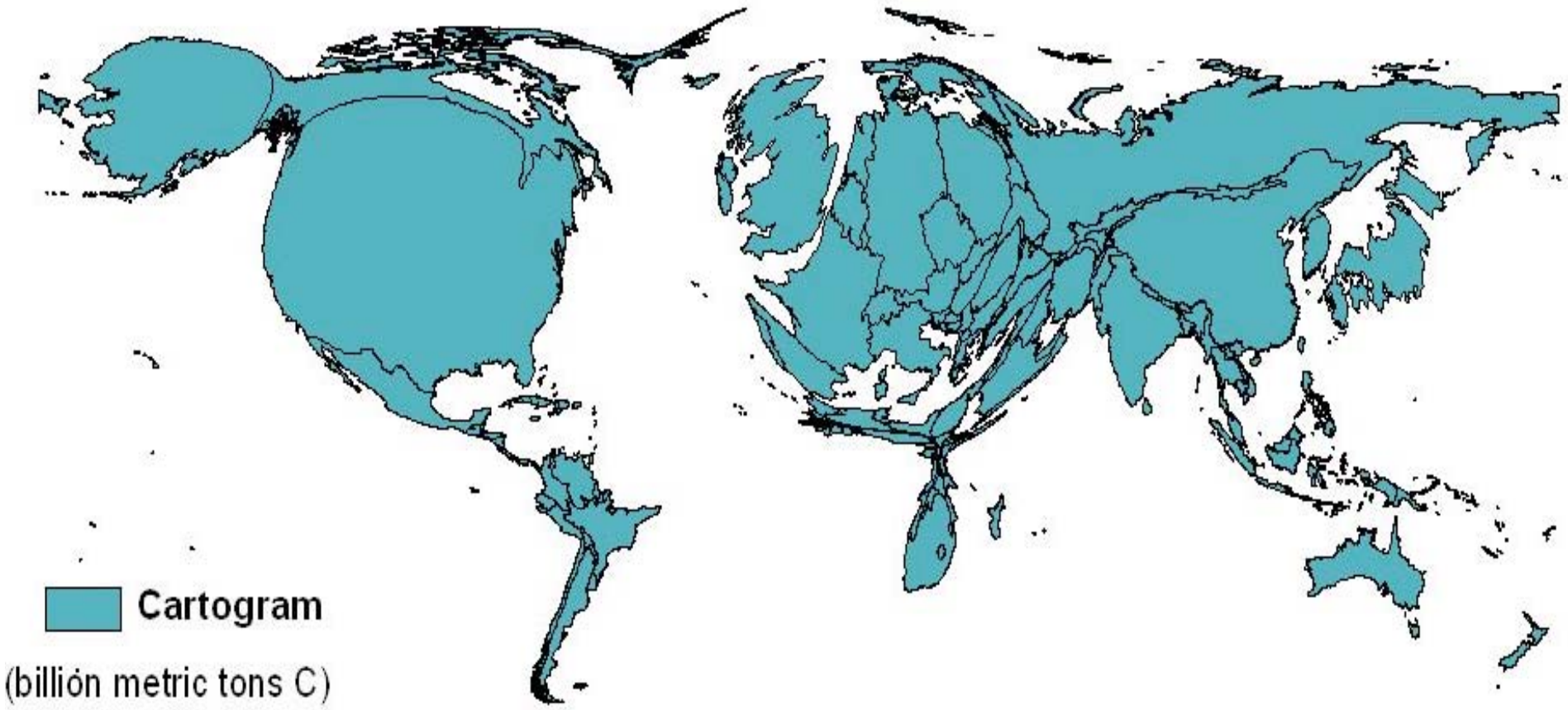
Cartogram of Climate-related Mortality (per million pop) yr. 2000



Gibbs et al. , in preparation

This map shows estimated mortality (per million people) attributable to climate change by the year 2000. Map is a density-equalizing cartogram in which the sizes of the 14 WHO regions are proportional to the increased mortality.

Total CUMULATIVE Greenhouse Gas Emissions in the Year 2002, by Countr



Gibbs et al. , in preparation

Responses?

- ~~MITIGATION~~
  - DOE and energy experts to tackle
    - Yet we have obligation to communicate health rationale & induce behavior and policy change as new climate-disease relationships are discovered
- ~~ADAPTATION~~
  - There will be some warming and we must protect the public (early warning & response, predictive modeling, engineering, etc.)

Why mitigation and Adaptation should be closely linked

Adaptation

Mitigation

Responses (frameworks continued)

- **MIDDLE GROUND -- Both mitigation/adaptation**

(full continuum of risk management strategies)

  - **Examples:**

    - **Co-benefits of reducing GHGs and urban pollution**

    - **Coastal Wetlands protection to reduce vulnerability to hurricanes**

    - **Environmentally sustainable urban design (reduced GHGs & promoting exercise/health**

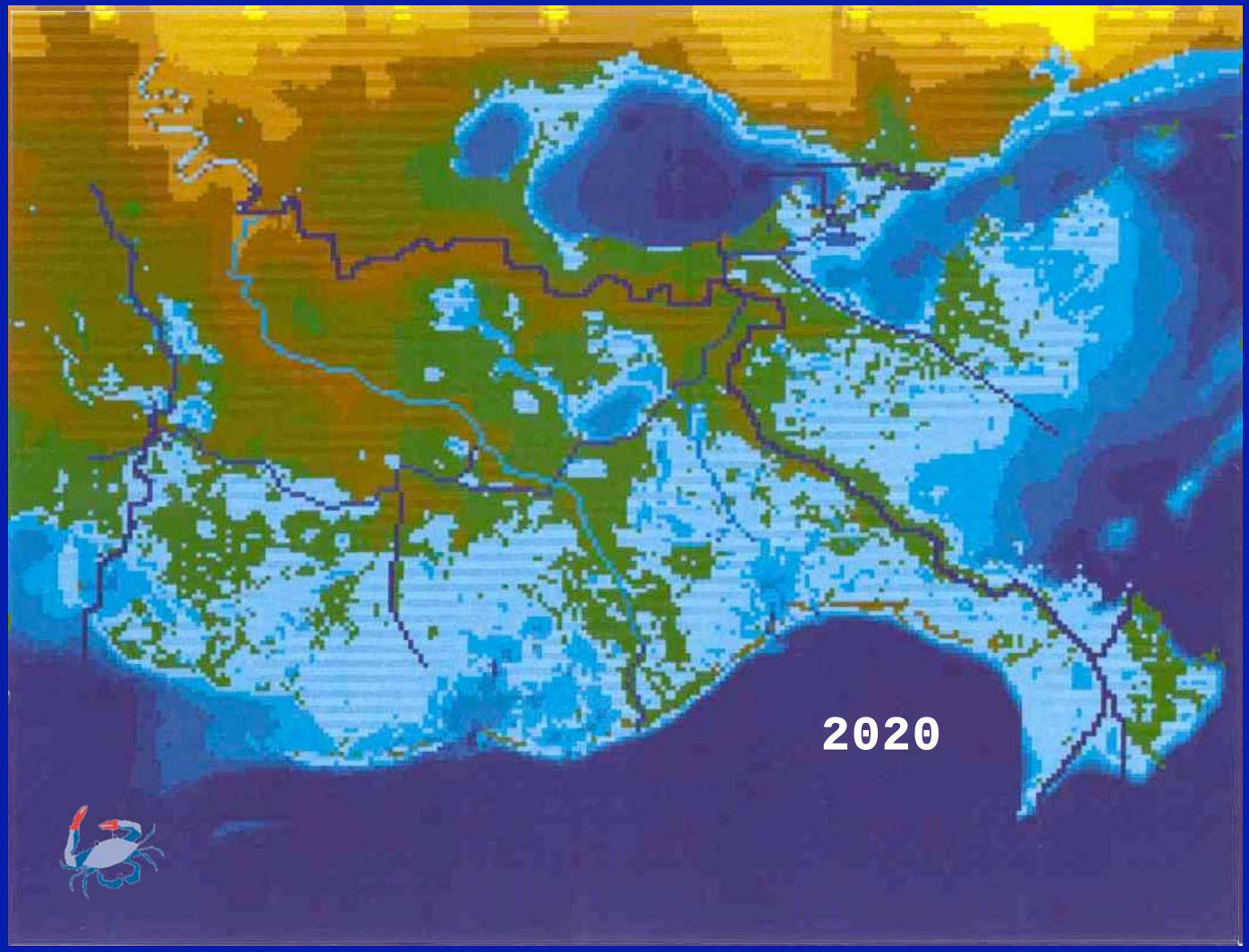
‘Co-Benefits’ of GHG Reduction

Fossil Fuels are source of GHGs and local air pollutants

- **Deaths from Air Pollution ranked within top 10 causes of disability**
- **460,000/yr avoidable deaths due to PM air pollution** (WHO, 1997)
- **3/4 of the world’s 24 megacities are in developing countries; GHG mitigation --> major ‘co-benefits’** (Cifuentes et al 2001)

sage

wetland loss in the Mississippi delta (1839 to 2020)



Barataria-Terrebonne Estuary Program

Heat Watch/Warning Systems

- Philadelphia (1995-98) estimated net benefits greatly outweigh costs (Ebi et al, 2004)
  - ≈ 117 lives saved translating into $468 million net benefits
- Preventive actions have minimal direct costs
  - $10 thousand
  - Incorporated into existing employee workload & volunteer assistance

EXCESSIVE HEAT WARNING
Dangerous heat stress conditions are forecast to occur within the next 24 hours.

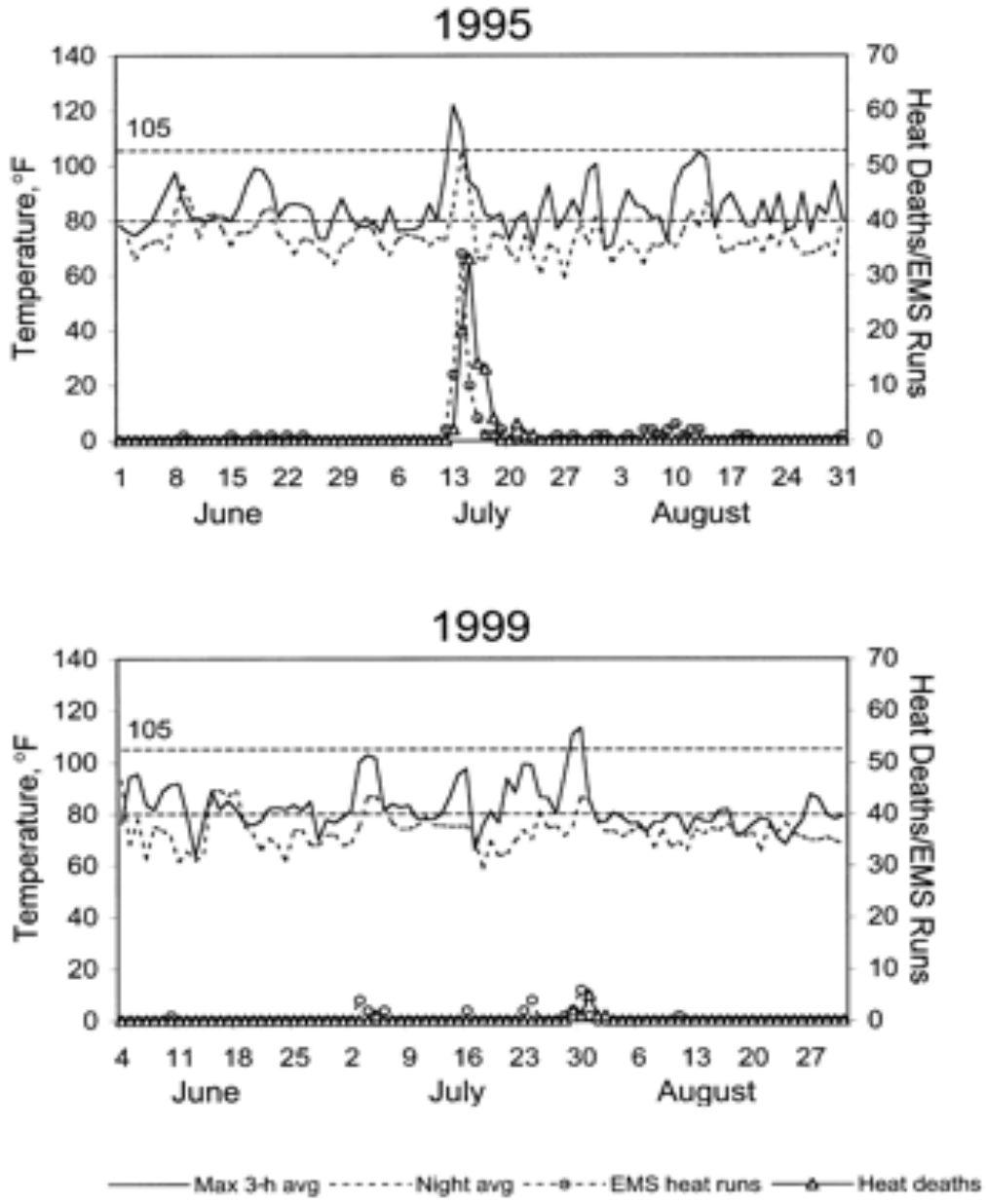
HEAT ADVISORY
Heat stress conditions are forecast to occur within the next 24 hours. Less than 5 excess deaths are forecast when the air mass is MT+.

EXCESSIVE HEAT WATCH
Heat stress conditions are forecast to occur in the next 24 to 48 hours.

EXCESSIVE HEAT OUTLOOK
Heat stress conditions are forecast to occur in the next 48 to 120 hours.

NO ADVISORY
Weather conditions are not forecastto be oppressive.

Heat Warning System-Milwaukee



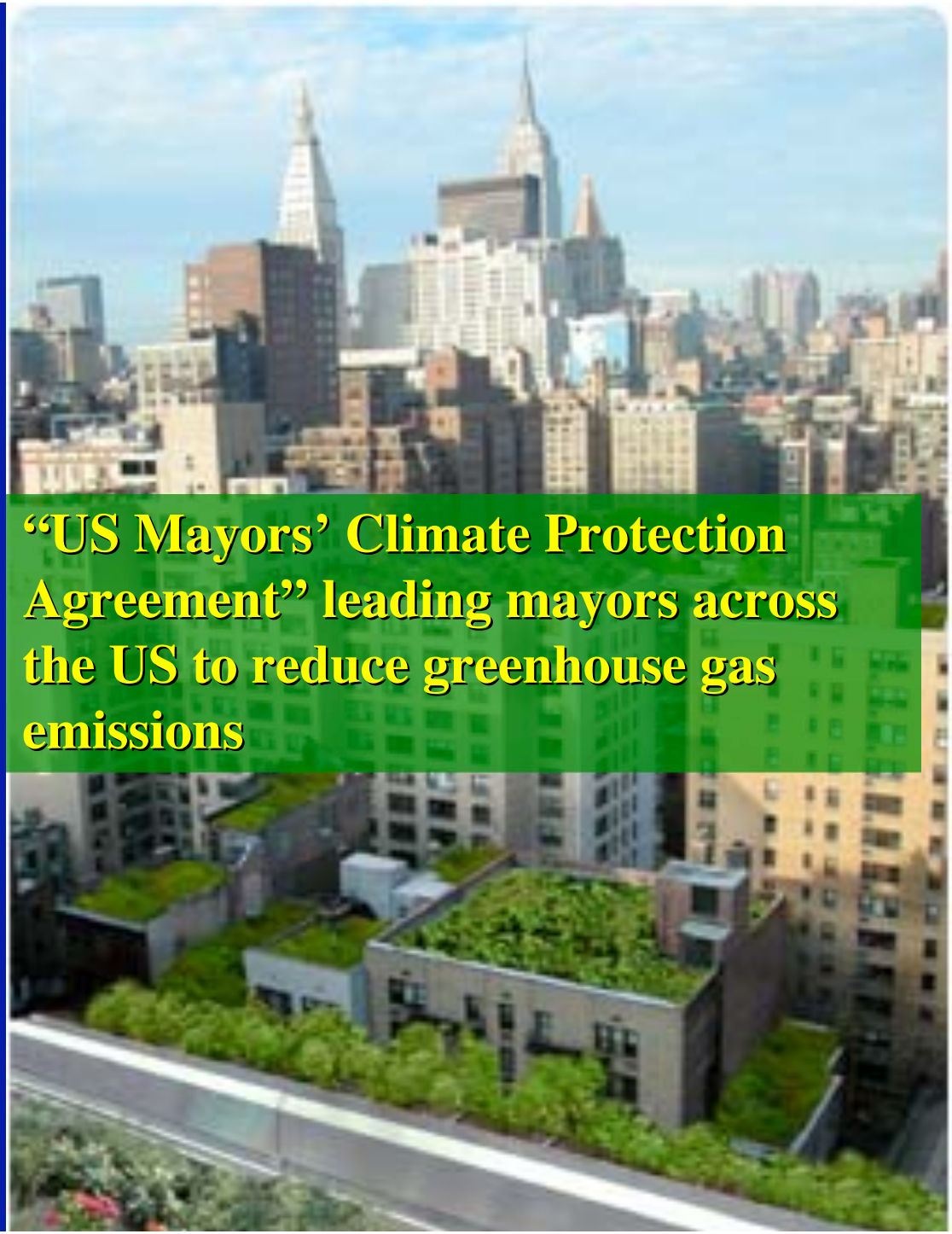
Following the 1995 heat wave, Milwaukee initiated an "extreme heat conditions plan" involving 20 agencies, communications tests, public/professional education efforts, stepped responses to early forecasts, 24-hour hotline and other interventions. Reductions in heat-related morbidity (measured by EMS runs) and mortality were reduced by ~50%, and were not attributable to differences in heat levels.

GREEN ROOFS

responds to:

- stormwater runoff
- urban heat island effect
- regional warming due to global climate change

SOURCE: Colin Cheney
Director | Earth Pledge Green Roofs Initiative



Responses by Health Officials Municipality Level

- Develop monitoring systems and communication methods to collect and disseminate information in timely way
- Adopt and enforce building & energy codes that max energy efficiency, as well as healthful indoor environments
- Incentivize carbon literate behaviors -- carbon labeling

Jackson & Shields, (in press) *ARPH*

Responses by Health Officials

State Level

- Support greenhouse gas emissions legislation (e.g, similar to California's)
- Incorporate energy and waste reduction targets into licensing agreements for health care facilities
- Provide state-level incentives for "carbon neutral" green building construction

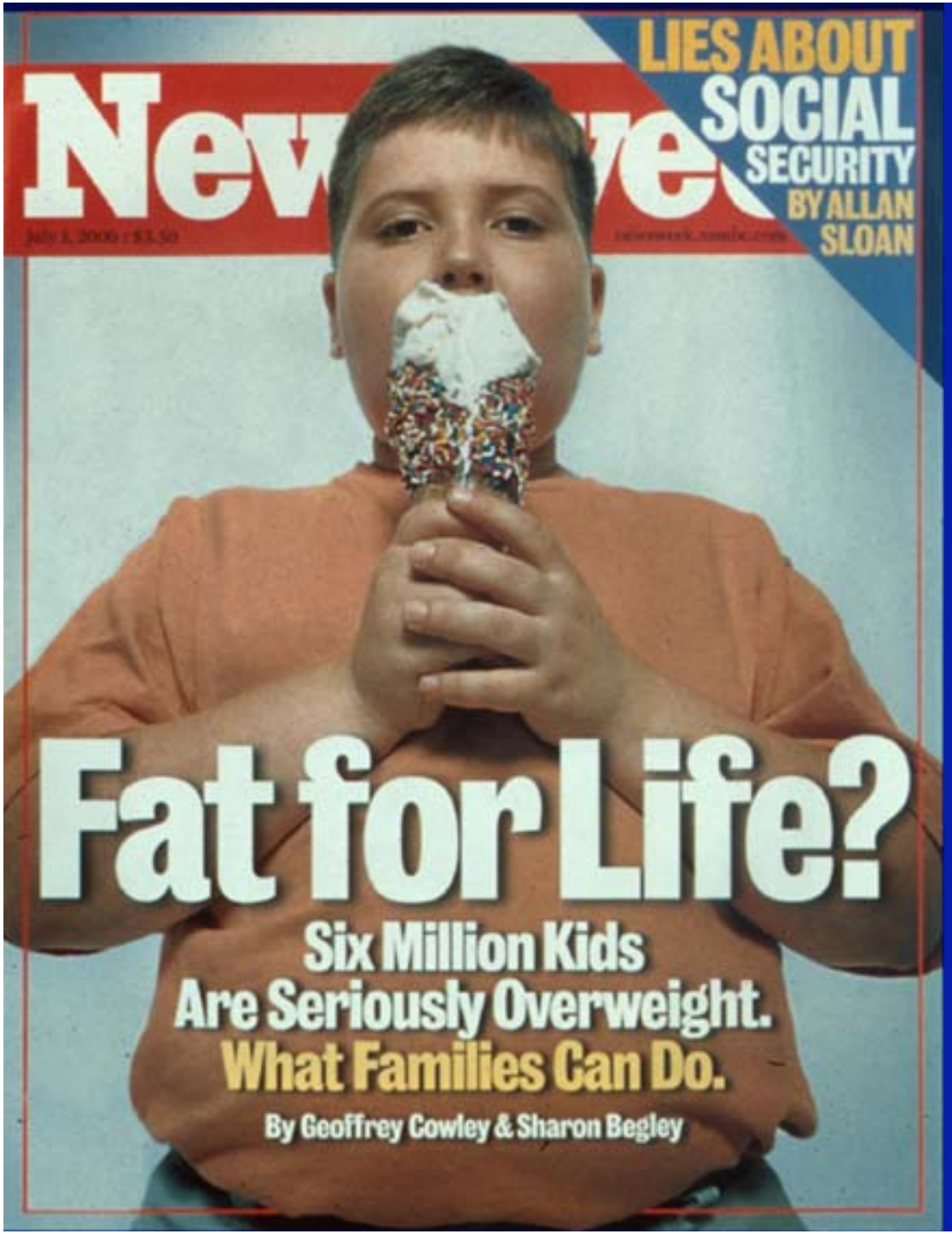
Jackson & Shields, (in press) *ARPH*

Responses by Health Officials

Cross-cutting Levels

- Require that all new and pending health care public health facilities be built to highest level of energy efficiency
- Advocate for a "climate change preparedness report card" -- should scrutinize health facility licensing and certification
- Advocate that environmental impact studies include energy efficiency and human health impacts

Jackson & Shields, (in press) *ARPH*



Two main factors:

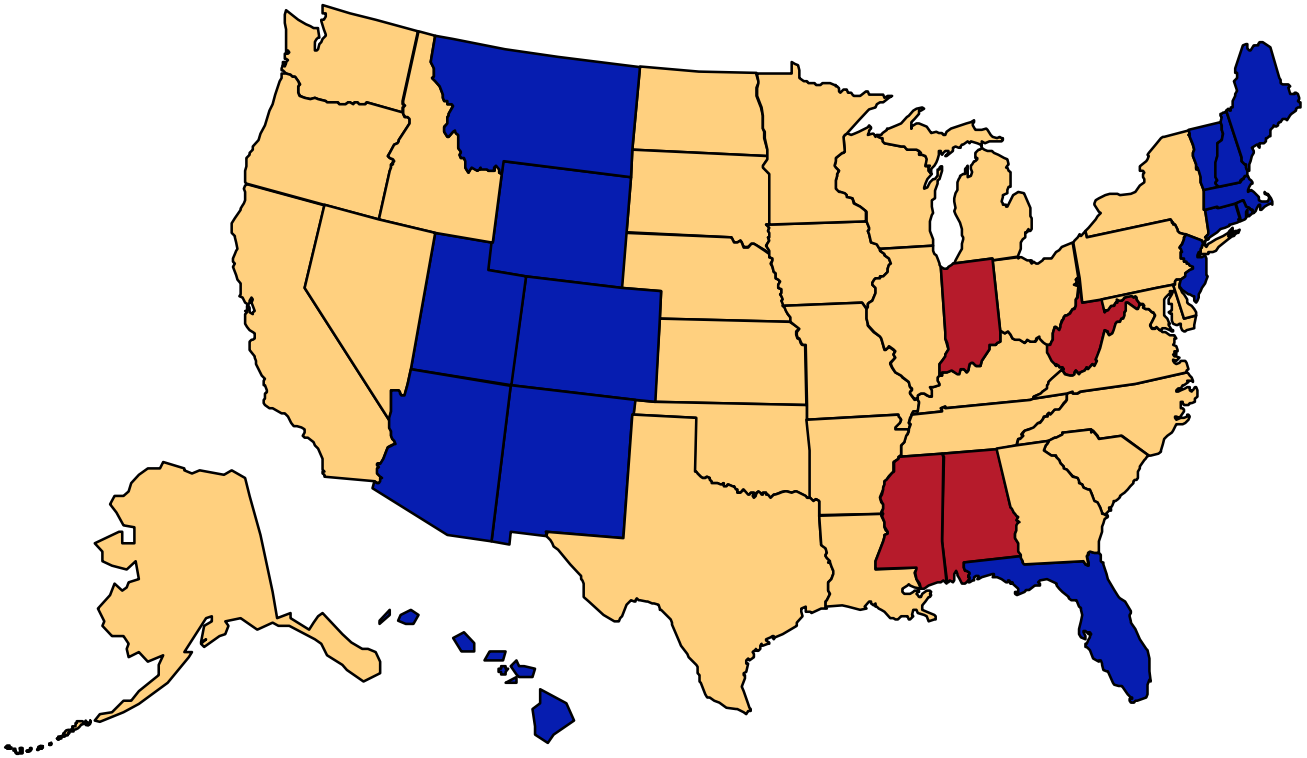
1) Mass marketing and availability of junk food and 'supersized' portions

2) Sedentary lifestyles (unhealthy urban and neighborhood designs lead both to obesity and greenhouse gas emissions)

--> Triple Win Biking case study

Obesity* Trends Among U.S. Adults
BRFSS, 2003

(*BMI ≥30, or ~ 30 lbs overweight for 5' 4" person)



No Data | <10% | 10%–14% | 15%–19% | 20%–24% | ≥25%

Triple Win Bike Project

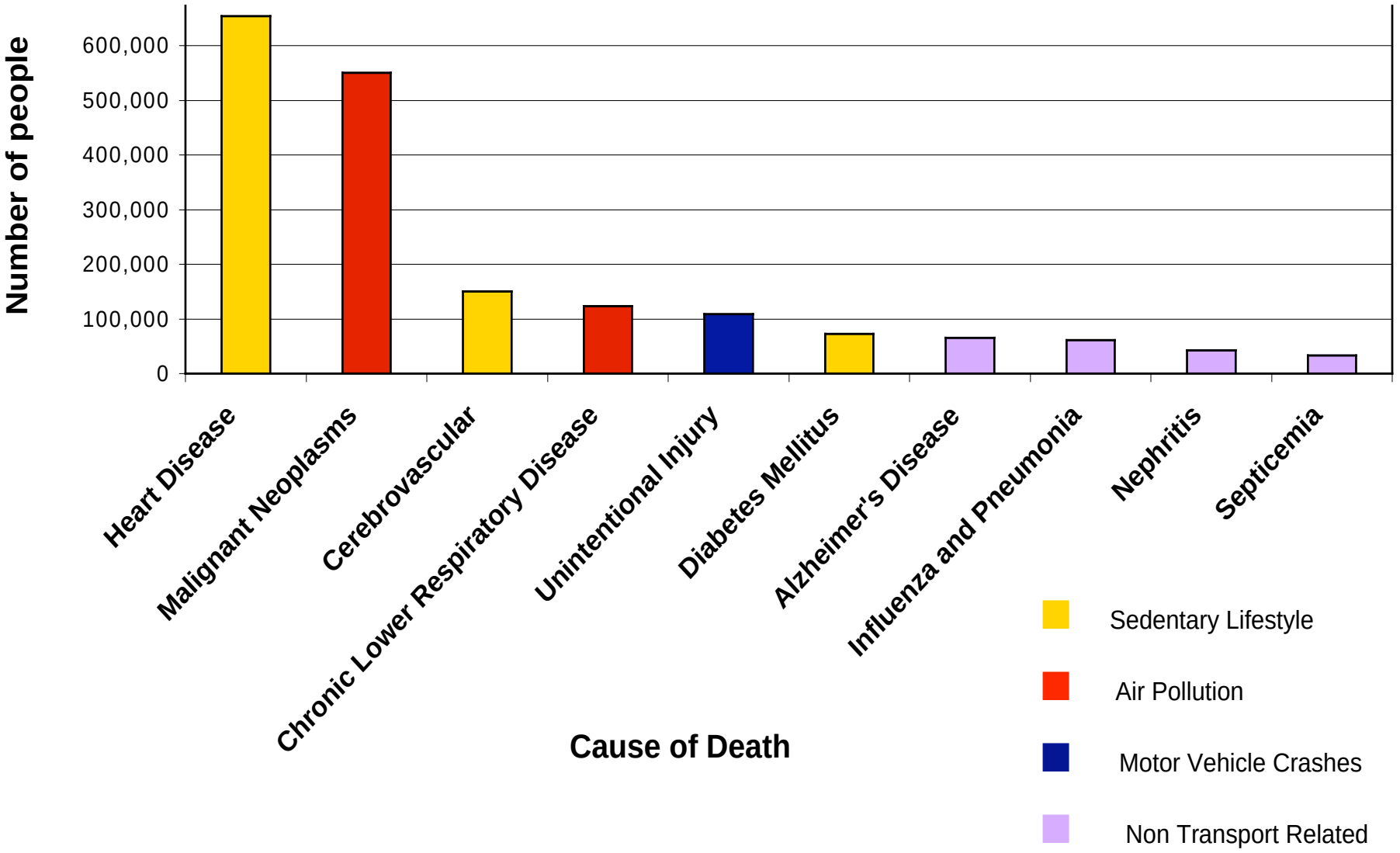
…OR Why global climate change could be the **greatest public health *opportunity*** we've had in over a century!

Status of Americans

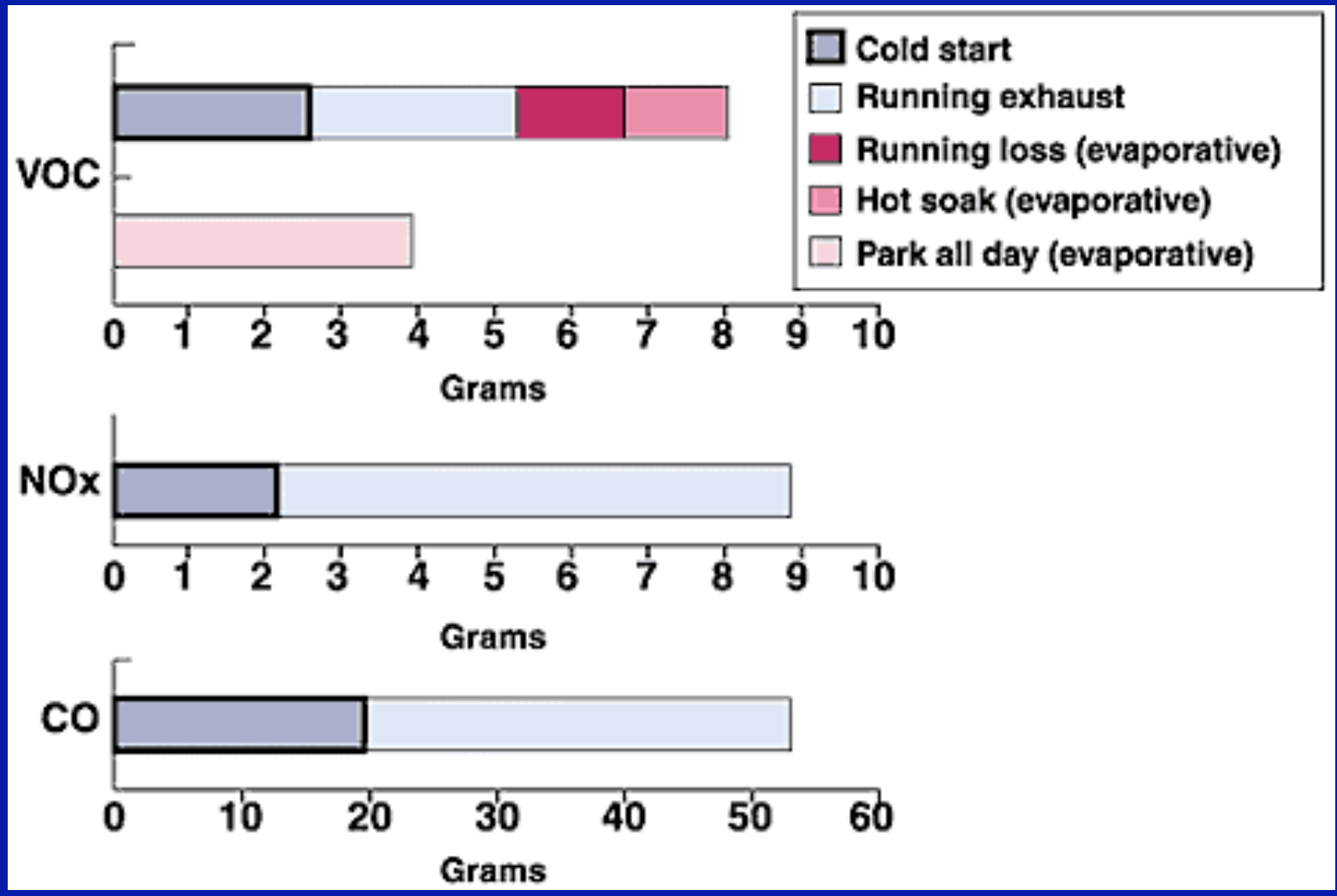
- ≈ 2/3 U.S. adults ≥ 20 are overweight or obese
- ≈ **15 %** of children and adolescents age 6-19 are overweight (CDC 2004).
- 20.8 million people have diabetes (7% of the population) (CDCP 2005)
- **60%** of American adults do not meet recommended levels of physical activity, and **25%** are completely sedentary (DHHS, 1996)

40% of trips by car are < 2 miles

Ten Leading Causes of US Deaths per Year (CDC, 2004)



Emissions of a Typical Car on the Road in 1997, for a 5-mile trip



Department of Transportation Federal Highway Administration

Benefits from Replacing Short Car Trips Bike Trips in Madison

	kcal	pounds	$PM_{2.5}$	VOC	NOx	O_3	CO_2
Personal Fitness	144.1 burned per day	9-10 lbs lost per yr					
Health and Local Air Quality	20% reduction in car trips		-2.07%	-6.33%	-12.21%	-12.21%	
	30% reduction in car trips		-3.10%	-9.50%	-18.32%	-18.32%	
	Health Outcomes					3.77% reduction in hospital admissions from pneumonia, pulmonary illness, chronic lung disease, and all other respiratory problems 5.93% reductions in hospital admissions from chronic bronchitis, pneumonia, and asthma	
	$ Saved from reduced medical costs and lost wages					$1,034,561.88	
Greenhouse Gas Emissions							16,687 tons 25,031 tons

Grabow et. al., in preparation

SOLUTION: The Eco City
Dongtan, China

ARUP 2007

…. Speaking of Urban Planning, it is ESSENTIAL TO TRAIN FUTURE HEALTH AND ENVIRONMENTAL LEADERS TO WORK ACROSS DISCIPLINES

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